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Affordances shape pass kick behavior in association football: effects of distance and social context

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AFFORDANCES SHAPE PASS KICK BEHAVIOR IN ASSOCIATION FOOTBALL: EFFECTS OF DISTANCE AND SOCIAL CONTEXT

KEYWORDS: Affordances, Pass-kicks, Association football, Ecological approach.

ABSTRACT: A prerequisite for accurate passing in association football is that a player perceives the affordances, that is, the opportunities for action, of a given situation. The present study examined how affordances shape passing in association football by comparing the performance of pass-kicks in two task conditions. Participants performed pass-kicks into either a stationary goal or to a teammate over a range of distances. The following passing action variables were measured: passing accuracy, pass preparation time, pass-kick technique, passing height, and passing velocity. Participants mainly used inside-foot pass-kicks with little to no height over the entire range of distances when the task was to perform pass-kicks into a stationary goal. However, when the task was to kick to a teammate, participants used inside-foot pass-kicks with little to no height for short distance passes and switched to relatively more instep-foot pass-kicks with more height for longer distances. Overall, pass preparation time increased with increasing distance, while participants took less time to prepare for pass-kicks to a moving teammate. The paper outlines these results in terms of the perception of (social) affordances for passing in football.

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— *Artículo invitado con revisión*

In association football, players are confronted with countless possibilities for action when in possession of the ball, such as a pass to a teammate, a pass in open space, a dribble down the pitch, or a shot at goal. Of all the available actions for a football player, passing is a frequently used action during a match; values of over 300 passes per team per match have been reported in the literature (Luhtanen, Belinskij, Häyrinen and Vänttinen, 2001; Yamanaka, Liang y Hughes, 1997; Zubillaga, Gorospe, Hernández-Mendo and Blanco-Villaseñor, 2007). Research indicates that association football players are capable of performing pass-kicks in a variety of situations. Throughout a match, passes are performed over short and long distances (Hughes, 2008), with success rates of seventy percent or more (James, 2006; Luhtanen et al., 2001). The importance of passing in association football is further underscored by the finding that at the highest level in association football longer passing sequences lead to more goals scored (Hughes and Franks, 2005). Hence, a good pass appears to be an important quality for a football player.

Little is known about what determines the actual execution of a pass. That is, why do players sometimes choose to kick with the inside of the foot, and at other times with the instep? Or why do players sometimes pass the ball through the air and at other times they pass it along the ground. Therefore, the main aim of the present study was to explore factors that shape the performance of pass-kicks in association football. In this paper we argue that it is not solely a matter of technical kicking abilities but that to a large extent perceptual constraints determine how a pass is executed. In an experiment we will show that the social context and the distance over which a pass needs to be performed influences how hard the ball is shot, with which part of the foot the pass is given, and the how accurate the pass is delivered.

Affordances for passing

The present research adopts the principles of ecological psychology (Gibson, 1979; Michaels y Carello, 1981; Reed, 1996) a scientific approach that emphasizes the importance of the sport specific environment on the emergence of sport behavior (see also Araujo, Davids y Hristovski, 2006). One of the fundamental concepts of ecological psychology is the notion of affordances. Gibson (1979) first created the term affordance as a noun, derived from the verb to afford. As stated by Gibson himself (1979, p. 127): "I mean by it something that refers both to the environment and the animal in a way no existing term does." Affordances are invariant properties of the environment that have consequences for behavior (Reed, 1996; Turvey, 1992). They can be defined as situation-specific opportunities for action which are dependent on a players' own specific action capabilities (Fajen, 2005a; 2005b; 2005c; 2007). For example, a free teammate positioned at a certain distance could afford passing for one player whilst not affording passing for another player because the action capabilities of this player do not match the requirements of the task at hand (i.e., passing).

Affordances are categorized into body-scaled and action-scaled affordances (Fajen, Riley and Turvey, 2009). Body-scaled affordances represent action possibilities which are determined by the relation between a certain measurable dimension of a player's body and a reciprocal environmental property, for instance a goalkeeper's own height relative to the height of the goal. Action-scaled affordances correspond to

action possibilities, which are determined by how the animal can behave relative to the environment, for example, and relevant for the purposes of the current study, the possibility of a football player to pass a ball. Players' action capabilities can be interpreted to be determined by various factors as a function of organismic, task, and environmental constraints (Newell, 1986). Organismic constraints refer to the unique personal characteristics of football players, such as fitness level, strength, speed, and other physical, physiological, emotional, cognitive and psychological factors. Task constraints include the specific goal of the task as well as rules, strategy and tactics inherent to association football. Environmental constraints refer to the environmental features (e.g., wind, temperature, and pitch) which influence the emergent behavior of the participants (Williams, Janelle and Davids, 2004; see also Davids, Button y Bennett, 2008).

It is important to stress that affordances are understood to be dynamic in nature due to a constantly changing environment which means that action possibilities come and go (Fajen et al., 2009; Oudejans, Michaels, Bakker and Dolne, 1996). At one moment a teammate can be open to receive a pass, whilst only a fraction later an opponent can be closing in. These rapid changes in the environment force association football players to make decisions under severe time pressure. From the opportunities for action afforded by the situation in relation to the action capabilities a player possesses, the action that will be most successful needs to be selected. The perception of action-scaled affordances is especially important here, since a good football player has to be aware of what can and needs to be done in any type of situation. Moreover, the perception of action-scaled affordances is important, not only in making decisions about the different categories of action (i.e., passing, dribbling or shooting), but also in the ongoing guidance of action, because the limits on players' capabilities place critical constraints on successful performance (Fajen et al., 2009). Association football players have to be aware of these constraints and have to act in such a way that the intended goal of the action is always afforded. Fajen (2007) referred to this as affordance-based control.

A considerable amount of research has been dedicated to investigate the perception of affordances in various everyday-like type of situations such as the step-on-ability of stairs (Warren, 1984; Wraga, 1999), pass-through-ability of apertures (Mark, 1987; Warren and Whang, 1987; Wraga, 1999), and overhead reach-ability (Pepping and Li, 2000; 2005; 2008). Most of these situations were examined in a laboratory setting, but have analogues in sport (Fajen et al., 2009). To our knowledge no such research has been performed to investigate affordances in the dynamic sport environment of association football. Moreover, association football is a team-oriented game. This means that football players have to work together in order to defeat the other team. Thus, football players do not only act upon affordances for themselves, they need to account for affordances for other players as well. Therefore, in team sports like association football, affordances not only operate on an individual level, yet also on a collective, social level. Affordances in a social context have been described as social affordances (Fajen et al., 2009; cf. Mark, 2007).

Three categories of social affordances can be distinguished. First, affordances for other people can be defined as the actions another player can perform in a certain situation. For

example, Ramenzoni, Riley, Davis, Shockley and Armstrong (2008) examined the ability to perceive the maximum height to which another actor could jump to reach an object and revealed that observers only made slightly more accurate judgments of their own maximum reach-with-jump height than when judging maximum reach-with-jump height of other actors. Further, observers were sensitive to changes in the actor's action capabilities when weights were attached to their ankles, thereby reducing the actor's jumping height.

Second, affordances for joint action can be defined as the actions a perceiver can perform cooperatively with one or more players. Richardson et al. (Richardson, Marsh and Baron, 2007) investigated the perception of intrapersonal, interpersonal, and tool-based grasping possibilities and they found that participants switched from one handed to two-handed grasping (i.e., intrapersonal), from two-handed to tool-based grasping, and from two-handed to two-person grasping (i.e., interpersonal) at similar action-scaled ratios. The results suggested that the spontaneous emergence of joint or tool-based activity originates from the perception of action-scaled animal-environment relations. One can think of affordances for joint action in association football when a team uses teamwork (i.e., joint action) to obtain possession of the ball by attempting to collectively chase the opponents for the ball.

Third and finally, affordances of other people can be defined as the actions another player affords for the perceiver. Very little research has examined this category of affordances but it should be clear that they play a major role in association football. A teammate may afford a pass when he is unmarked and within suitable distance but he might not when there is a defender nearby.

In summary, we argue that the performance of a pass kick is a function of (the availability of) opportunities for action - affordances - relationships between football players and their environment. As such, affordances can be said to invite football players to perform certain actions (cf. Withagen, de Poel, Araujo and Pepping, 2011). For example, a situation with an unmarked teammate may invite a player to perform a pass. An open goal may invite a player to shoot. To further illustrate, if you see your teammate running very fast in a specific direction, this invites for a longer pass than if he/she would be standing still. The affordance for you to give a specific pass resides in the possibility of your teammate to reach such a pass, hence the opportunity for action. What is important to understand from all of this is that the specific performance of a pass - how long a player takes to prepare for it, the speed of the kick, which technique: inside foot or instep, and the height of the pass - are predicted to be determined by the (social) affordances available for the player in a given situation.

The current study examine how a change in task goal shapes the pass an experiment was performed in which football players performed pass-kicks under different task circumstances. That is, players had to pass over varying distances either to a fellow player or into a small stationary practice goal. Both forms of passing are used in practice in varying training situation. The task condition in which players had to pass to a fellow player more strongly resembles/represents the game situation compared to the stationary goal condition. We were particularly interested in how this variation of task goals affected the specific execution of the pass kicks. In the first task condition, hereafter called the stationary goal (SG)

condition, participants performed pass-kicks into a small, stationary goal. In the second task condition, hereafter called the moving teammate (MT) condition, participants performed pass-kicks to another participant. To examine how different combinations of task demands (i.e. distance and social context) affect the actor - environment relationship for passing and how they may invite and shape action various variables related to passing accuracy, pass preparation time, pass-kick technique, passing height, and passing velocity were measured.

The current study was exploratory in nature but it was expected that the various combinations of task demands would have differential effects on the means of the various action variables measured. Specifically, Smith y Pepping (2010) have shown that when actors have to perform at their action boundaries they take longer to prepare the action. This would predict that when at participants have to kick over distances that are nearer their action boundary for accurate passing they will take longer to prepare their kick. Finally, in accordance with Fitts' law (Fitts, 1954, see also Beilock, Bertenthal, Hoerger and Carr, 2008; Sachlikidis and Salter, 2007) it was expected that participants would lower ball speed when distance increased in order to maintain pass-kick accuracy.

Methods

Participants

Participants were 8 male students from the University of Groningen (*M* age = 23.5 years; *SD* = 1.69 years). All participants had extensive experience in regional level competitive association football (*M*= 14.3 years; *SD* = 4.83 years). Participants played on different positions for their clubs (5 midfielders, 2 defenders and 1 attacker). Five participants reported their right foot as their preferred foot, 3 participants reported their left foot as their preferred foot.

Material

The experiment was performed outside on an artificial association football pitch of standard size. Participants wore their own football equipment. A small goal (104 x 72 cm) was placed on one end of the experimental setup, which covered an area of approximately 60 meters in length and 35 meters wide. Seven distances were marked by two small cones in line with each other with the goal in the center (see Figure 1). In the MT condition the goal was removed and

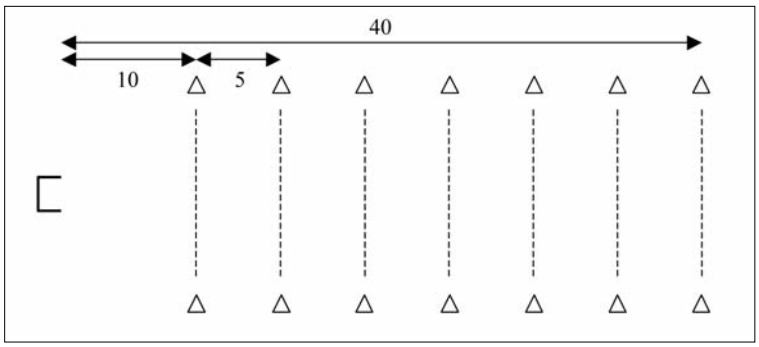

Figure 1. Schematic representation of the experimental setup. Distances are shown in meters.

replaced by two cones, which were placed in the same fashion as the other cones, that is, in line with the others.

An official professional association football competition ball (Derbystar Brillant, regulation size 5, FIFA approved) was used in the experiment. Both conditions were recorded with a high definition video camera (Canon HF100), which was positioned approximately 25 meters from the side of the experimental setup, to obtain an overview (i.e. in length) of the setup. In addition, during the MT condition two regular camera's (Sony DCR-HC51; Panasonic NV-GS320) were placed approximately 10 meters behind both ends of the experimental setup. The camera's were positioned by using either the cones marking the first distance, or in case of the second camera, the cones marking the last distance as reference points by placing them in the outer edges of the frame of the camera's. The video footage was analyzed with the help of behavioral analysis software program Noldus (version 8.0) through manual frame-by-frame coding.

Procedure

Before the start of the experiment, participants received a form with information on the experiment and instructions about the procedures to follow. In addition, participants were asked to fill in a number of anthropometric items along with a few association football-related questions. After the participants completed this form, they were free to ask questions about the experiment to ensure that they understood the testing procedure. Subsequently, participants were given time to perform a brief warm-up with the ball before the start of each condition in order to get familiar with the experimental task and setting.

In the SG condition participants had to perform pass-kicks into the small, stationary goal. Each participant took 5 pass-kicks from seven distances, which led to a total of 35 pass-kicks per participant and 280 pass-kicks for the total group. Due to measurement issues one pass-kick was excluded, which means that 279 pass-kicks were included in the final video analysis. No instructions whatsoever were provided regarding the use of any type of pass-kick. In addition, it was specifically stated that they were allowed to take as much time for each pass-kick as they wanted. Furthermore, participants were instructed to place a foot on the ball before the start of each pass-kick. The experimenter verbally called out each distance. The MT condition was carried out by two participants simultaneously and consisted of performing pass-kicks to one another. It was specifically stated that the receiving participant should only move sideways in order to keep the distance between both participants even. The test procedure was identical to that in the SG condition. Both conditions took about 15 minutes to complete.

Experimental design and variables measured

The sequence of completion of the conditions was counterbalanced over all participants; one half of the group of participants started with the SG conditions and finished with the MT condition, while the other half started with the MT condition and finished with the SG condition. The order in which the distances were presented was completely randomized in both conditions. Furthermore, in the MT condition, the sequence of passing was counterbalanced between participants in order to eliminate any learning effects.

Distance was coded from 1 to 7, which represented the seven distances. The time

participants took to prepare for each pass-kick was used as a measure for preparation and was taken from the time participants put their foot on the ball indicating the start of the next trial until the moment they kicked the ball (so preparation time included the moment participants took their foot of the ball, walked back to the start of their run up, and initiated their run up). Preparation time was coded as a mutually exclusive start-stop behavior. The time that it took the ball to travel the respective distance was used as a measure for pass-kick duration. Pass-kick technique was coded as one of two types of technique, that is, the inside or instep of the foot. Inside-foot pass-kicks were defined as pass-kicks taken with the medial surface of the foot. Instep-foot pass-kicks were defined as pass-kicks taken with the frontal aspect of the foot. Pass-kick height was coded categorically as low, medium or high. Low pass-kick height indicated a ball travelling over the ground for all of the way to the goal or the teammate; medium pass-kick height corresponded to a ball travelling through the air as well as over the ground for part of the way; high pass-kick height indicated a ball travelling through the air for most of the way to the goal or the teammate. Pass-kick outcome was coded differently in both conditions. In the SG condition, pass outcome was coded as a score, post, or miss. In the MT condition, the number of correctional steps (i.e., the number of steps taken by the receiving participant in order to control the pass-kick with a maximum of 4 steps) was coded from 0 to 4.

Statistical analysis

Ball speed was calculated for each pass-kick by dividing pass-kick time by the corresponding distance in meters. Pass-kick technique was transformed from a nominal variable with two categories into a numerical dichotomous variable. A value of 0 was used for pass-kicks taken with the inside of the foot and a value of 1 for pass-kicks taken with the instep of the foot. The mean values for pass-kick technique (in each task goal x distance condition) hence varied between 0 and 1. Pass-kick height was transformed from a nominal variable into a numerical categorical variable with three values, that is, 0 for low pass-kicks, 1 for medium, and 2 for high. Consequently, mean values for pass-kick height ranged from 0 to a maximum of 2. Mean pass-kick outcome in the SG condition was calculated as the percentage of goals scored and in the MT condition as the amount of correctional steps (ranging from 0 - 4) needed.

In order to assess reliability of the video analysis, the main observer as well as two additional observers viewed and scored pass-kick performance of one single subject in both conditions, that is, 70 pass-kicks in total for each observer. Cohen's kappa was used as a statistical measure for the assessment of the inter- and intra-observer agreement of the categorical variables pass-kick technique, pass-kick height and pass-kick outcome. Values of Cohen's kappa were interpreted according to guidelines adopted from Landis and Koch (1977), who classified kappa values of < .20 as poor agreement, of .21-.40 as fair, of .41-.60 as moderate, of .61-.80 as good, and of .81-1.00 as very good agreement. In addition, Intraclass Correlation Coefficients (i.e., ICCs) were calculated in order to determine inter- and intra-observer agreement of the time-related measures preparation time and pass-kick time using a two-way mixed model approach with absolute agreement.

A Repeated Measures ANOVA was performed with task-goal condition (two levels, that is, SG and MT) and distance (seven levels, that is, the seven distances) as within-subjects factors. The means of preparation time, pass-kick time, ball speed,

pass-kick technique and pass-kick height functioned as dependent variables. In addition, separate Repeated Measures ANOVA's were performed for the outcome-related variables with distance as within-subjects factor and the condition specific outcome-related measure as dependent variable. When the assumption of sphericity was violated, a Greenhouse-Geisser correction was applied on the *F*-values of the univariate test results only for those variables, which violated the assumption. Throughout the analysis, alpha was set at .05.

Results

Reliability analysis

Percentages agreement for the variables were all above 90%, except for the number of correctional steps in the MT condition which was just below 80% inter-observer and just below 90% intra-observer. Average kappa values for the variables pass-kick technique, pass-kick height, and pass-kick outcome ranged from 0.70 - 1.00, which means good - perfect agreement. Pass-kick height in the SG condition both for inter- and intra-observer, and the number of correctional steps in the MT condition inter-observer were classified as good agreement. In all other cases, kappa values were classified as at least very good agreement. Intra-observer values for percentage agreement and Cohen's kappa were equal to or higher compared to inter-observer values for all variables except for percentage agreement of pass-kick height in the SG condition. Average ICC values for preparation time and pass-kick time ranged from 0.90 to 1.00, indicating close to perfect inter-observer as well as intra-observer agreement for these measures. The average ICC value was lowest for the pass-kick time variable in the MT condition inter-observer, yet still very high, that is, 0.90. Mean ICC values for intra-observer agreement were higher or at least equal to mean ICC values for inter-observer agreement.

Time-related measures

Preparation time: A significant main effect of task condition was found on mean preparation time, $F(1, 7) = 10{,}81$, $p < .05$, partial $h^2 = .61$. The mean preparation time in the SG condition was 4.08 sec. compared to 2.82 sec in the MT condition. Hence, in the SG condition participants took 1.23 sec. longer to prepare for their kick. Moreover, there was a significant main effect of distance on mean preparation time, $F(6, 42) = 29.49$, $p < .05$, partial $h^2 = .81$. Preparation time increased from 2.02 sec. when participants kicked over 10 meters to 4.89 sec. when passing distance was 40 meters. Finally, there was a significant task condition x distance interaction effect on mean preparation time, $F(6, 42) = 6.11$, $p < .05$, partial $h^2 = .47$, partial $h^2 = .47$ (see Table 1 and Figure 2A). The difference in preparation time between the two task conditions decreased from 1.7 sec. when passes were kicked over 10 meters to 0.48 sec. when the distance was 40 meters.

Pass-kick time: Surprisingly, no effect of task condition was found on mean pass-kick time, $F(1, 7) = 1.36$, $p > .05$. However, the analysis did reveal a significant main effect of distance on mean pass-kick time, $F(1.45, 10.17) = 106.21$, $p < .05$, partial $h^2 = .94$ (see Table 1). Mean pass-kick time increased from 1.04 sec. to 3.56 sec when passing distance increased from 10 to 40 meters. In addition, the analysis revealed a significant interaction effect between task condition and distance on mean pass-kick time, $F(1.85, 12.94) = 9.48$, $p < .05$. For pass-kicks over 10 meters participants' pass-kick time was shorter (0.28 sec.) in the SG condition compared to the MT condition, whilst for pass-kicks over 40

	Preparation Time (s)		Pass-kick Time (s)	
Condition	SG	MT	SG	MT
Distance (m)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
10	2.87 (0.76)	1.17 (0.39)	0.90 (0.10)	1.18 (0.21)
15	3.47 (0.75)	1.66 (0.57)	1.26 (0.18)	1.48 (0.19)
20	3.92 (0.72)	2.01 (0.44)	1.75 (0.23)	1.86 (0.15)
25	3.98 (0.74)	2.63 (0.86)	2.23 (0.32)	2.09 (0.27)
30	4.36 (0.74)	3.42 (0.74)	2.72 (0.32)	2.33 (0.26)
35	4.61 (0.81)	4.20 (1.21)	3.30 (0.32)	2.77 (0.40)
40	5.13 (0.98)	4.65 (1.05)	3.78 (0.49)	3.34 (0.48)

Note. SG denotes the stationary goal condition and MT denotes the moving teammate condition.

Table 1. Means (and Standard Deviations) for preparation time and pass-kick time per distance separately for each task condition.

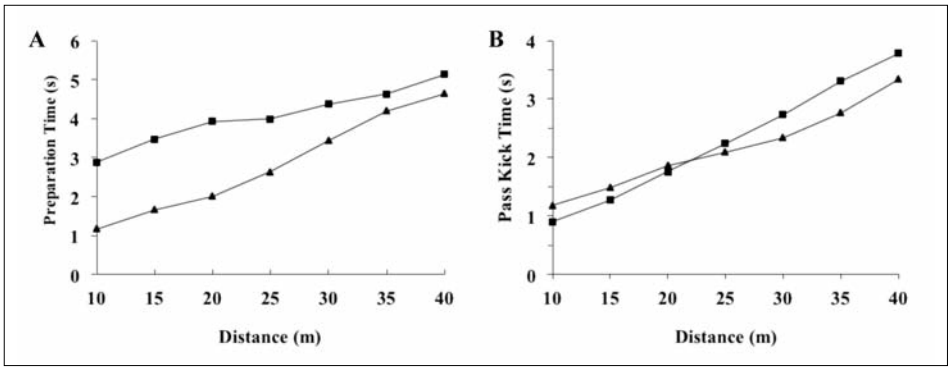

Figure 2. Participants' average preparation time (A) andpass-kick time (B). The stationary goal condition is denoted by squares (■)*, the moving teammate condition by triangles* (▲).

meters pass-kick time was shorter (0.4 sec) in the MT condition when compared to the SG condition (see Table 1 and Figure 2B).

Pass execution-related measures

Ball speed: No effect of task condition on mean ball speed was found, $F(1, 7) = .28$, $p > .05$. More surprisingly, there was no effect of distance on mean ball speed, $F(1.42, 9.92) = .84$, $p > .05$. However, there was a significant task condition x distance interaction effect on mean ball speed, $F(2.68, 18.78) = 16.88$, $p < .05$, partial $h^2 = .71$. Over the shorter (10 - 20 meters) distances participants passed the ball (from 3.61 m/s^{-1} to 1.12 m/s^{-1}) faster in the SG conditions whilst over the longer (25 - 40 meters) distances participants passed the ball (from 0.14 m/s^{-1} to 1.45 m/s^{-1}) faster in the MT condition (see Figure 3).

Pass-kick technique: A significant main effect of task condition was found on mean pass-kick technique, $F(1, 7) = 10.93$, $p < .05$, partial $h^2 = .61$. Participants used the instep kick significantly more often in the MT condition. Furthermore, the analysis revealed a significant main effect of distance on mean pass-kick technique, $F(6, 42) = 9.00$, $p < .05$, partial $h^2 = .56$. Over 10 - 20 meters all kicks were performed with inside foot kicks whilst when distance increased more kicks were taken with instep foot kicks. In the 40 meter kicks 45% of the kicks were instep foot kicks (see also Table 2). Furthermore, a significant task condition x distance interaction effect was found on mean pass-kick technique, $F(6, 42) = 6.81$, $p < .05$, partial $h^2 = .49$. At 25 meters in the SG condition all kicks we made with the inside of the foot whilst in the MT condition participants used the instep of the foot in 25% of the kicks. When kick distance increased this difference in the use of the instep kick further increased up to 30% when kicks were made over 40 meters. At this distance in the SG condition 30% of the kicks were made with the inside of the foot whilst in the MT condition participants used the instep of the foot in 60% of the kicks (see Table 2, and Figure 4A).

Pass-kick height: There was a significant main effect of task condition on mean pass-kick height, $F(1, 7) = 24.02$, $p < .05$, partial $h^2 = .77$. More height was used in passing in the MT condition. Furthermore, there was a significant main effect of distance on mean pass-kick height, $F(6, 42) = 54.83$, $p < .05$, partial $h^2 = .89$. Only over the shortest two distances was the ball passed with no height. When passes were made over longer distances passes used increasingly more height (see Table 2). Finally, the analysis revealed a significant interaction effect between task condition and distance on mean pass-kick height, $F(6, 42) = 12.72$, $p < .05$, partial $h^2 = .65$. In the MT condition participants used increasingly more height over longer passing distances compared to the SG condition (see Table 2, and Figure 4B).

Percentage of goals scored: A significant main effect of distance was found on the average percentage of goals scored in the SG condition, $F(6, 42) = 37.78$, $p < .05$, partial $h^2 = .84$ (see Table 3 and Figure 5A and 5B). Fewer goals were scored when passes were made over longer distances.

Number of correctional steps: The analysis revealed a significant main effect of distance on the average number of correctional steps in the MT condition, $F(6, 42) = 34.94$, $p < .05$, partial $h^2 = .83$ (see Table 3 and Figure 5B). Over longer distances more correctional steps were necessary to control the ball when receiving a pass.

Discussion

The primary objective of the present study was to examine how (social) affordances

	Ball Speed (m/s)		Pass-kick Technique		Pass-kick Height	
Condition	**SG**	**MT**	**SG**	**MT**	**SG**	**MT**
Distance (m)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
10	12.80 (1.46)	9.19 (1.66)	0.00 -	0.00 -	0.00 -	0.00 -
15	13.06 (1.81)	10.83 (1.53)	0.00 -	0.00 -	0.00 -	0.00 -
20	12.23 (1.57)	11.11 (0.86)	0.00 -	0.00 -	0.03 (0.06)	0.05 (0.11)
25	12.12 (1.52)	12.26 (1.63)	0.00 -	0.25 (0.33)	0.03 (0.06)	0.43 (0.60)
30	11.64 (1.25)	13.12 (1.43)	0.05 (0.07)	0.53 (0.06)	0.23 (0.30)	1.25 (0.42)
35	11.10 (1.18)	12.94 (1.74)	0.15 (0.12)	0.65 (0.12)	0.40 (0.37)	1.78 (0.29)
40	11.08 (1.52)	12.53 (1.84)	0.30 (0.21)	0.60 (0.14)	0.60 (0.53)	1.75 (0.31)

Note. SG denotes the stationary goal condition and MT denotes the moving teammate

Table 2. Means (and Standard Deviations) for ball speed, pass-kick technique and pass-kick height per distance separately for each task condition.

shape passing behavior in association football by comparing the performance of pass-kicks in two task goal conditions over a range of distances. In the stationary goal condition participants performed pass-kicks into a small, stationary goal. In the moving teammate condition participants performed pass-kicks to a teammate.

Participants used inside-foot pass-kicks with little to no height over distances up to 20 meters. Instep-foot pass-kicks were used more often when kicking to a moving teammate, but only from distances exceeding 20 meters. Participants barely used instep-foot pass-kicks when kicking into a stationary goal, and only over distances exceeding 25 meters. In addition, they did not use much height over the entire range of distances. When performing pass-kicks to a moving teammate, participants rapidly increased kick height over distances exceeding 20 meters.

Ball speed was highest when performing pass-kicks into a stationary goal over distances up to 20 meters. After that ball speed was highest while performing pass-kicks to a moving teammate. Ball speeds in the current

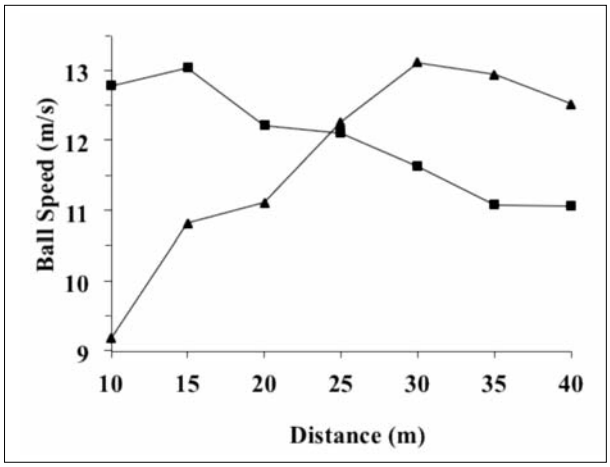

Figure 3. Average ball speeds over the distances. The stationary goal condition is denoted by squares (■)*, the moving teammate condition by triangles* (▲).

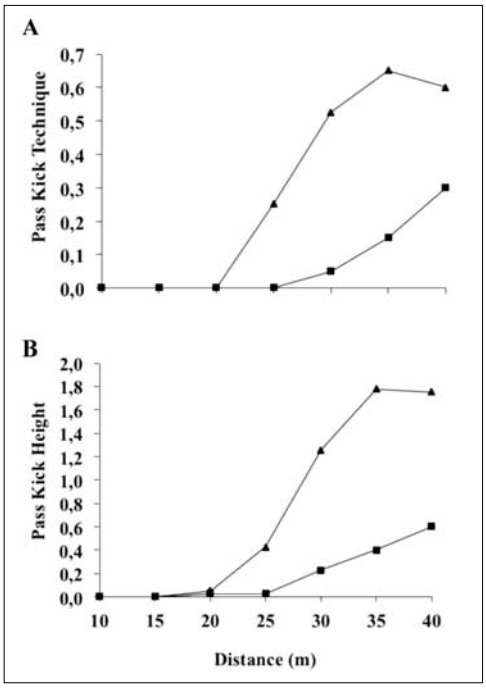

Figure 4. Participants' average pass-kick technique (A) and pass-kick height (B). The stationary goal condition is denoted by squares (■) *and the moving teammate condition by triangles* (▲)*. Pass-kick technique ranges from 0 (i.e., inside-foot) to a maximum value of 1 (i.e., instep-foot) and pass-kick height ranges from 0 (i.e., low), followed by 1 (i.e., medium), to a maximum value of 2 (i.e., high).*

	Percentage of goals scored		Number of correctional steps	
Distance (m)	*M*	*SD*	*M*	*SD*
10	82.5	30.5	0.50	0.48
15	67.5	44.2	0.53	0.48
20	31.3	40.2	1.00	0.67
25	35.0	49.8	1.60	0.86
30	12.5	19.3	1.98	1.07
35	2.5	5.6	2.90	0.97
40	2.5	5.6	3.38	0.83

Table 3. Means (and Standard Deviations) for the percentage of goals scored in the stationary goal condition and means and standard deviations for the number of correctional steps in the moving teammate condition.

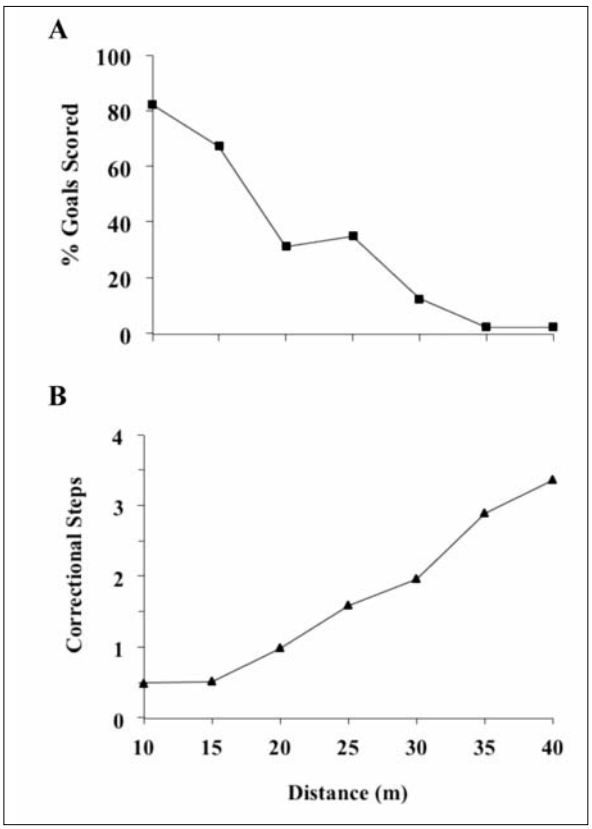

Figure 5. Participants' average percentage of goals scored (A) in the stationary goal condition, denoted by squares (■), and the average number of correctional steps (B) in the moving teammate condition, denoted by triangles (▲).

study were much lower than ball speeds reported elsewhere both for inside-foot pass-kicks and instep-foot pass-kicks (Kawamoto, Miyagi, Ohashi y Fukashiro, 2007; Kellis and Katis, 2007; Levanon and Dapena, 1998; Nunome, Asai, Ikegami and Sakurai, 2002). However, in these studies participants typically perform pass-kicks using maximum effort without any additional task constraints.

The inside-foot pass-kick is regarded as the common type of kick for passes or shots over shorter distances when precision is the main focus, while the instep-foot pass-kick is considered as the common type of kick for passes or shots over longer distances requiring greater speed (Kawamoto et al., 2007; Nunome et al., 2002). Indeed also in the current study the stationary goal afforded participants to perform pass-kicks mainly focused on precision and use of the inside-foot kick with little to no height even over long distances. On the other hand at larger distances participants switched to another form of pass-kicks when they kicked to a moving teammate. These findings share similarities with those from other research on affordances, in which transitions between movement patterns were found. For instance, when actors are required to walk through a door they switch to another movement pattern (i.e., they introduce trunk rotations) at a certain critical door-width relative to their shoulder-width (Warren et al., 1987).

In general, participants became less accurate when distance increased, which was reflected by a lower number of goals scored and a higher number of correctional steps needed by the receiving participant. Further, overall participants took less time to prepare for pass-kicks to a moving teammate. However, the difference in preparation time decreased with each increase in distance. Smith and Pepping (2010) investigated how action timing varies as a function of a continuum of afforded action. Embarking on the idea that affordances should be regarded to exist on a continuum, affordance perception around an action-boundary was examined. It was shown that action initiation time varies as a function of afforded action around an action-boundary. Results indicated that judgments were quick and accurate at the extremes of the affordance scale. The main finding of Smith y Pepping (2010) were congruent with the findings reported here; when actors need to perform an action near an action boundary it takes longer for the affordance to become actualized, that is, actors take longer to initiate the action.

Smith and Pepping (2010) offered various explanations for their findings, which are of relevance in the present study. First, the longer preparation times observed when participants perform near an action-boundary may have been caused by weak information-action coupling due to the availability of more than one action solution, a case of multiple actions being afforded. So as the number of afforded actions increases around the action-boundary preparation time would also be expected to increase in accordance with Hick's Law (Hick, 1952). Alternatively, at the action-boundary, the information may be of little relevance to either response action, in which case it may not specify any affordance. In this instance, long preparation times would reflect the lack of information–action coupling. When preparation time is considered as the time taken to identify the task-relevant information necessary to constrain the action dynamics, fast action responses may reflect the effectiveness of the information in constraining the action. This suggests that short preparation times, observed at shorter distances in both task conditions, are indicative of optimal affordance perception,

where information was highly effective in constraining the action. Conversely, longer preparation times are associated with the action-boundary where information is less effective in constraining the action. Further research is clearly warranted but it is argued that the time taken to prepare and initiate an action provides a good means of quantifying the sensitivity to action-boundaries and ease and extent of affordance perception (Smith and Pepping, 2010).

With regards to ball speed the findings were not in accordance with Fitts' law. Ball speed dropped only slightly when distance increased, and more importantly, it did not affect accuracy in a positive way. Fitts' law is a widely studied phenomenon which has been examined almost exclusively in a non-sport context involving relatively simple tasks such as grasping, reaching and pointing (see for example Bootsma, Marteniuk, Mackenzie and Zaal, 1994; for a review see Plamondon and Alimi, 1997). However, in a sports context the speed-accuracy trade off has received much less attention (for exceptions see Sachlikidis and Salter, 2007; and Beilock et al., 2008).

The current study can be used as a starting point for future research on passing in association football, since it is one of the first studies attempting to investigate the performance of pass-kicks in a setting representative of an association football environment. The knowledge gained with the relatively simple experiment of the present study can be applied in more advanced match-related situations. For example, it is relevant to incorporate more complex situations involving for instance a higher number of players including opponents as well as fellow teammates. In this way, the experimental setup becomes even more representative of actual match situations, since more variables such as time, pressure, speed and decision-making come into play. Another relevant point for future research would be to use a moving instead of a stationary ball, since in an actual match football players only perform pass-kicks with a stationary ball from set plays (e.g., free kicks, corners) and more frequently perform pass-kicks with a moving ball (Egan et al., 2007).

In the present study association football players of different skill level and from different positions were included. One may expect players from certain positions to differ in pass-kick performance from players on other positions (e.g., midfielders versus defenders) (see Taylor, Mellalieu, Stephen and James, 2005). The same can be said for a comparison between high-level and low-level association football players (e.g., professional association football players versus amateur players). Consequently, it is important to compare players of different skill levels or from different positions. Findings from such research could be beneficial for coaches and association football players, since they can point out positional differences in passing which can help to improve performance.

In conclusion, passing in football is the interplay between the individual capabilities of a football player and the available opportunities for action in the football environment. Affordances in association football are relationships between players and their football environment, which invite the player to perform specific actions. Although the presented data are exploratory by nature, the results show how (social) affordances shape passing behavior in football. In order to promote optimal decisions in football it is important for players to know what they can do in a specific situation by being able to perceive what is going on around you, that is, players need to perceive the affordances. As shown here, these relationships between environment and player are decisive for the performance of pass kicks.

LOS "AFFORDANCES" CONFIGURAN LA REALIZACION DE PASES EN FUTBOL: EFECTOS DE LA DISTANCIA DE PASE Y DEL CONTEXTO SOCIAL

PALABRAS CLAVE: Affordances, Pase, Fútbol, Perspectiva ecológica

RESUMEN: Un requisito previo para la precisión en el pase en fútbol es que el jugador perciba las affordances, es decir, las oportunidades para la acción, de una situación dada. El presente estudio examinó las affordances del pase comparando la eficacia en dos condiciones de trabajo. Los participantes realizaron el pase a un objetivo fijo, y a un compañero de equipo a diferentes distancias. Las variables de acción evaluadas fueron: la precisión del pase, el tiempo de preparación, la técnica de ejecución, la altura y la velocidad del pase. Los participantes ante la tarea de pasar a un objetivo fijo, utilizaron principalmente el interior del pie, con poca o ninguna altura. Sin embargo, cuando la tarea era pasar a un compañero de equipo, los participantes utilizaron el interior del pie con poca o ninguna altura cuando la distancia de pase era corta, y utilizaron con mayor frecuencia el empeine y mayor altura cuando la distancia de pase era más larga. En general, utilizan más tiempo de preparación al aumentar la distancia, aunque utilizaron menos tiempo de preparación del pase cuando lo realizaban a un compañero de equipo en movimiento. El estudio presenta los resultados en términos de la percepción de las affordances para la ejecución del pase en fútbol.

AS AFFORDANCES CONSTRANGEM O COMPORTAMENTO DE PASSE EM FUTEBOL: EFEITOS DA DISTANCIA E DO CONTEXTO SOCIAL

PALAVRAS-CHAVE: Affordances, Passe, Futebol, Perspectiva ecológica

RESUMO: Percepcionar affordances, isto é, as oportunidades para a acção numa determinada situação, é um pré-requisito num passe preciso no futebol. O presente estudo analisou como as affordances moldam o passe no futebol, através da comparação da performance em duas condições de passe-remate. Os participantes realizaram esta acção para um alvo estático ou para um colega de equipa, localizados a diferentes distâncias. Foram medidas as seguintes variáveis, no que concerne à acção de passar: precisão no passe, tempo de preparação do passe, técnica de passe-remate, altura do passe e velocidade do passe. Os participantes usaram, maioritariamente, o interior do pé no passe-remate, com uma altura de inexistente a baixa, em todas as distâncias, quando a condição era realizá-lo para um alvo estático. No entanto, quando a condição era passar a um companheiro de equipa, os participantes usaram o interior do pé, com uma altura de inexistente a baixa, para passes-remates de curta distância, mudando para passes com o peito do pé, mais altos, nas distâncias mais longas. No geral, o tempo de preparação do passe aumentou com a distância, sendo que os participantes demoraram menos tempo na preparação de um passe-remate para um companheiro de equipa em movimento. Estes resultados são

enquadrados no artigo em termos da percepção de affordances (sociais) para passar no futebol.

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